

REDUCING ORGANIC CONTAMINATION IN NASA JSC ASTROMATERIAL CURATION FACILITY.

M. J. Calaway¹, C. C. Allen², and J. H. Allton². ¹Jacobs Technology (JETS) at NASA Johnson Space Center, Astromaterials Acquisition and Curation Office, Houston, TX; michael.calaway@nasa.gov. ²NASA Johnson Space Center, Astromaterials Acquisition and Curation Office, Houston, TX.

Introduction: Future robotic and human spaceflight missions to the Moon, Mars, asteroids and comets will require handling and storing astromaterial samples with minimal inorganic and organic contamination to preserve the scientific integrity of each sample. Much was learned from the rigorous attempts to minimize and monitor organic contamination during Apollo, but it was not adequate for current analytical requirements; thus [1]. OSIRIS-REx, Hayabusa-2, and future Mars sample return will require better protocols for reducing organic contamination.

Organic Contamination Baseline: Future isolation containment systems for astromaterials, possibly nitrogen enriched gloveboxes, must be able to reduce organic and inorganic cross-contamination. In 2012, a baseline study established the current state of organic cleanliness in gloveboxes used by NASA JSC astromaterials curation labs that could be used as a benchmark for future mission designs [2, 3]. After standard ultra-pure water (UPW) cleaning, the majority of organic contaminants found were hydrocarbons, plasticizers, silicones, and solvents. Hydrocarbons loads ($> C7$) ranged from 1.9 to 11.8 ng/cm² for TD-GC-MS wafer exposure analyses and 5.0 to 19.5 ng/L for TD-GC-MS adsorbent tube exposure. Plasticizers included < 0.6 ng/cm² of DBP, DEP, TXIB, and DIBP. Silicones included < 0.5 ng/cm² of cyclo(Me₂SiO)_x ($x = 6, 8, 9, 10$) and siloxane. Solvents included < 1.0 ng/cm² of 2-cyclohexen-1-one, 3,5,5-trimethyl- (Isophorone), N-formylpiperidine, and 2-(2-butoxyethoxy) ethanol. In addition, DBF, rubber/polymer additive was found at < 0.2 ng/cm² and caprolactam, nylon-6 at < 0.6 ng/cm².

Reducing Organics: The Apollo program was the last sample return mission to place high-level organic requirements and biological containment protocols on a curation facility. The high vacuum complex F-201 glovebox in the Lunar Receiving Laboratory used ethyl alcohol (190 proof), 3:1 benzene/methanol (nano grade solution), and heat sterilization at 130°C for 48 hours to reduce organic contamination. In addition, both heat sterilization and peracetic acid sterilization were used in the atmospheric decontamination (R) cabinets. Later, Lunar curation gloveboxes were degreased with a pressurized Freon 113 wash. Today, UPW has replaced Freon as the standard cleaning procedure, but does not have the degreasing solvency power of Freon.

Future Cleaning Studies: Cleaning experiments are currently being orchestrated to study how to degrease and reduce organics in a JSC curation glovebox lower than the established baseline. Several new chemicals in the industry have replaced traditional degreasing solvents such as Freon and others that are now federally restricted. However, these new suites of chemicals remain untested for lowering organics in curation gloveboxes. 3M's HFE-7100DL and DuPont's Vertrel XF are currently being tested as a replacement for Freon 113 as a degreaser at JSC curation facilities. In addition, the use of UPW as a final rinse is being tested, which presumably can maintain a lower total organic carbon load than the filtered purity of chemical solutions.

References: [1] Allton J.H. et al. (2012) *LPS XLIII*, 2439; [2] Calaway M.J. et al. (2013) *LPS XLIV*, 1241; [3] Calaway M.J. et al. (2013) *LPS XLIV*, 1242.